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MR RICHARD H. KARNEY, P.E.
MANAGER, ENERGY STAR PROGRAM
BUILDING TECHNOLOGIES PROGRAM
US DEPARTMENT OF ENERGY
1000 INDEPENDENCE AVE SW
WASHINGTON DC 20585

COMMENTS OF THE OREGON OFFICE OF ENERGY

on the:

Analysis and Proposals for Energy Star Criteria for RESIDENTIAL WATER HEATERS

These are the comments of the Oregon Office of Energy on the D&RI research, analysis and proposals for an Energy Star program component for residential water heaters published on April 4, 2003.

We find the research and proposals presented for comment at this time to be reasonably thorough in covering the issues, and we find it convincing, though perhaps not in the way you had hoped. We are convinced that there should be no Energy Star program component for residential water heaters. Stated another way, we find no compelling case for such a component, while at the same time finding many problems with the concept as presented.

Summary

There are critical flaws in the underlying structure of the proposals, as well as in the analysis that seems to lead to them. From our perspective, the end use and technology to be addressed is residential water heating. The Department has gone to some trouble to provide consumers with a reasonably straight-forward method for doing an "apples-to-apples" comparison of these technologies. It's called the Energy Factor, which is thought to be (and is required to be by law) a reasonable representation of the annual efficiency of technologies used to heat water for residential use. Our comments here are based on long experience with programs promoting the use of efficient water heating equipment, all of them based on the generic use of the Energy Factor as the efficiency metric.

As pointed out in the D&RI research, there are issues other than efficiency that come into play when choosing a particular technology to deliver hot water. We will discuss the results of our own experiences in these areas as we comment on specific parts of the analysis. But we agree that they will be a significant factor in deciding whether or how the Department chooses to proceed with an Energy Star water heater program component.

Technology Distinctions

In spite of the single annual efficiency metric provided for by uniform test methods and standards, for the Energy Star program the Department seems determined to arbitrarily subdivide the equipment choices into smaller compartments than is justified. First there's the fuel subdivision, which is admittedly common. Then there's the storage versus instantaneous subdivision. And then the renewable versus non-renewable subdivision, which seems to be why solar finds itself fitting so uneasily into the picture.

In fact, only one of these subdivisions is useful or desirable. The only "natural" distinction that makes itself apparent is the different *ranges* of possible efficiencies for the various individual fuel types. This makes a distinction by fuel more of a fact than a construct, and so seems acceptable in a program meant to convey relative efficiency to consumers, without a fuel bias. As oil-fred water heaters are a more simple case, for discussion purposes, we'll leave them out until our conclusions near the end of our comments.

The proposed distinction between electric resistance and heat pump water heaters, and between storage-type and instantaneous natural gas-fired water heaters is highly inappropriate. While there are certainly application issues associated with the more advanced technologies, as always, the relative efficiencies, as measured by the Energy Factor, are absolutely an indicator of a consumer's annual energy bills for heating water with each type. Even DOE rose above such distinctions when setting the initial Energy Factor standard for instantaneous natural gas- or propane-fired models (as noted at the top of page 7 in the D&RI report, USDOE applied the 1991 standard for storage-type water heaters as the first minimum for these, thus making distinction by factors other than fuel more questionable). On an Energy Factor basis, for each fuel, there are two apparent levels of efficiency above the 2004 standard: 1) a very modest step, analyzed by D&RI at EF 0.94 for the electric type, and at EF 0.63 for the natural gas-fired type; and 2) a significant step, analyzed by D&RI at EF > 1.0 (heat pump) for the electric type, and EF 0.82 for the natural gas type. If one studies the "Qualifying/Available Models" column in the table on page 5 of the report, one can see just how modest the first step of improvement is; 40 percent of electric models and 77 percent of oil-fired models would qualify, as proposed.

We'll comment shortly on those EF selections, but for now we wish to point out the remarkable similarities between the EF ranges for each of the two fuel types being discussed. In both fuel cases, there is only limited "room" above the current standard level for improvement of the "standard" technologies, which are of a simple storage tank variety in both cases. This also happens to be the case for oil-fired equipment. And in both cases, the next level of efficiency above this modest step is delivered by a different, but common, technology. In the case of the electric fuel, it's a heat pump water heater. For natural gas, it's the instantaneous (on-demand) or condensing efficiency technologies. In both of these cases: 1) there are application issues that can complicate a consumer's choices and the tailoring of individual installations, 2) there is a

significant price premium, 3) there is a significant savings bonus, and 4) there are market issues and barriers that make significant market shares for the best technologies more of a long term goal.

We find it interesting that the Department seems so intent on including solar water heating systems in the program. If any of the proposed technologies deserves distinction as a class for the purposes of the program, it's this one. And yet DOE is determined to lump it in with the electric technologies. Why is this? In most cases, this type of system has a more conventional back-up fuel, but it is by no means a given that it is electric. In our area, the Bosch/AquaStar line does a brisk business in providing the AQ-125BS instantaneous model as the back-up for solar systems. Moreover, just as the electric instantaneous units are incapable of fully meeting the hot water demands of a typical residential household, so too are most solar systems. In Oregon, most of these systems provide about 40 percent of the household's hot water needs, similar to the gpm fraction of whole-house flow rate demand provided by instantaneous electric models. **So we are completely at a loss to understand why the Energy Star program is so determined to include this type of system, when by the criteria used to judge the other technologies, it clearly doesn't fit. Except, of course, in its own fuel class, like the others.**

We also found the suggestion by manufacturers that "they couldn't presently make a cost-effective residential gas condensing water heater" to be rather glib. Cost-effective compared to what? Most applications of this technology that we're familiar with provide not only domestic water heating, but also space heating. What fraction of the cost of such models is attributed to the water heating function, and what fraction to the space heating function, which is generally provided at an efficiency of 90 percent or higher? The test method for this equipment is usually ANSI/ASHRAE 124-1991, which delivers combined system efficiency numbers. The water heating efficiency is generally a bit better (CA_{ef} of 0.84-0.86) than that of most instantaneous models. If one apportions the cost of such models appropriately (three quarters of the combined efficiency rating weight comes from the CA_{afue} rating), and given that they can provide space heating efficiencies at the condensing level, we find these models to be quite cost-effective, compared to more conventional *combinations* of space heating and water heating equipment. **So we're not convinced that these models deserve any special distinction, other than fuel type, and should be classified with instantaneous models simply as the upper end of the natural gas or propane efficiency scale.**

In summary, except by fuel, just because DOE makes a class distinction between residential water heating technologies when providing for uniform test methods doesn't mean that it's appropriate for the Energy Star program to do likewise. This fact makes all of the current program proposals highly questionable.

The Analysis

There are a few troubling elements in the analysis presented, beyond the way the technologies are grouped for comparison. These include:

1) The base case electric water heater is appropriately assigned an EF rating at the level of the 2004 standard. **Why is the assigned EF rating for the base case natural gas-fired water heater below that required by the 2004 standard?** Would that have an impact on the incremental cost used for the comparison perhaps? **The appropriate base case EF for the gas-fired water heaters is 0.59.**

2) **We find no compelling reason to choose EF 0.82 as the analysis level for the more advanced instantaneous gas-fired models.** While the statistical methods applied (and depicted in the Appendices on page 20) are valid enough in and of themselves, there are too few models in this case to warrant the use of such methods. Instead, it would be more appropriate to simply use the EF ratings of the models near the bottom of this upper range of efficiency as representative of their type. To do otherwise tends to result in resting this part of the analysis on the product(s) of one manufacturer. Consistent with other parts of the analysis, this level of efficiency should be compared against the gas-fired base case of EF 0.59.

3) **With regard to gas economics, we gather that the analysis uses a fixed price for natural gas, and that it is hopelessly outdated.** While it may be the average price used for Energy Guide label computations at present, we assert once again that such prices are hopelessly outdated. The price of residential natural gas is likely to rise 20 percent or more before any water heater component of this program goes into effect. Further significant price increases are likely in the several years after 2004. Consequently, any valid economic analysis should at least account for the *possibility* of fuel price increases by using a fuel price escalation rate. The beginning price should be the Department's best guess about prices in the marketplace in January, 2004. Of course, there will be electricity price escalation associated with the natural gas price increases, and that should be treated as suggested for the natural gas case. **To ignore the virtually certain rises in fuel prices in this analysis significantly distorts the basis for the program and its promotion to consumers.**

4) At the end of the first paragraph on page 9, under "**Scope**," D&RI states that, "At this time, no *advanced technologies* [emphasis ours] exist for gas/oil water heaters comparable to solar or heat pump in the electrical product classes." On the contrary. **Both condensing tank-type technologies and the instantaneous technologies should be so classified.** While the savings fraction may be somewhat lower for the gas-fired technologies when compared to their electric cousins, there are enough similarities (enumerated above) that they should be treated the same for program purposes.

5) D&RI goes on to say that "the increased capital cost of heat pump and solar water heaters would make these products too expensive for many consumers." True enough. But when such products as heat pump water heaters are used intelligently, there are benefits beyond hot water. Air conditioning, for one. In widespread use, heat pump water heaters also have a very positive impact on utility peak demand, thus beneficially impacting the rates consumers pay for all of their annual kilowatt-hours.

At the same time the ancillary benefits of the heat pump relative to other technologies are discounted, D&RI unfairly discounts the direct benefit - the energy savings - relative to other technologies. At the bottom of page 12, the authors refer to the concept of space heating interaction, stating that, "The added heat load in the heating season is a negative consequence, although the energy benefit of this water heater typically outweighs the added space heating requirement." The authors distort the picture. First, space heating only applies in some applications, specifically those where the functioning of the water heater interacts with the space heating thermostat. This is a subset of the installations considered to be "inside the heated envelope." Second, and more important, there is no mention anywhere in this analysis of the space heating interaction of most gas-fired water heaters located "inside the heated envelope." In such installations, at a 45,000 Btu/hour firing rate, 30-35 cubic feet per minute of space heated house air goes up the flue, and is replaced by cold outside air in the heating season and warm humid air in the cooling season. At least in the heat pump water heater case, the space conditioning impact, if any, is welcome in the cooling season. Not so in the case of the gas-fired equipment. Of course, with the gas-fired instantaneous models, firing at much higher rates, indoor air losses are much greater (70 cfm or more). **If the Department is not prepared to thoroughly investigate space heating interaction and quantify its impact on energy savings for all technologies relevant to this discussion, we suggest that this issue be dropped altogether. This means that unless the space heating interaction induced by gas-fired equipment is included, the "Added Heat Load" paragraph on page 15 should disappear.**

6) As for Fuel Switching (page 14), we find the discussion here to be so incomplete as to be unrepresentative of reality. The first sentence in this section can only be supported with highly misleading assumptions. In our region, with natural gas priced at $1.02 per therm, and electricity at $.07 per kWh, it would cost a consumer 30 percent more for water heating annually if they use an EF 0.63 natural gas water heater than if they use a heat pump water heater with a COP of 2.0. So from that perspective, the heat pump is more economical. Only at $.10 per kWh does the picture begin to balance in the other direction. While there are a number of people nationally who pay more than this, many of those people also pay more than $1.02 per therm for natural gas.

And then there's the physics. If we look just at the performance of a typcial gas-fired combustion turbine (7,400 Btu/kWh), add to that transmission and distribution losses, and compare the overall efficiency of that same COP 2.0 heat pump water heater to the direct combustion of natural gas at 63 percent efficiency, the heat pump wins again (80 percent to 63 percent). It takes some pretty ugly electric generation equipment to make natural gas-fired equipment, operating at 63 percent annual efficiency, look like a relatively intelligent choice. And while we admit to the existence of a significant amount of coal-fired generation in the country, **we don't find the kind of blanket statements used in this report with regard to fuel choice to be very helpful or enlightening. Nor do we consider them at all relevant to the Energy Star program.**

7) As for usage, the statements of the report's authors are once again misleading. They state that, "Customers with little hot water usage (such as single or double occupant of a home) may not see the economic benefit of either a heat pump water heater or a solar water heater, versus conventional electrical storage technology." Based on the Oak Ridge National Laboratory research on heat pump water heater performance in the field, and our own research on solar water heating systems, there is a clear link between lower usage (lower hot water loads) and the performance of water heating systems that use a back-up heat source. The average COP of heat pump water heaters, and the fraction of the total water heating load served for solar water heaters, rises as the load declines. This is because both systems draw less on back-up energy sources when loads are smaller. This fact isn't addressed at all in the analysis or the report.

In any event, we find the age-old DOE household daily use number of 64.3 gallons to be substantially too large for our own region. Extensive research here suggests that 51-53 gallons per day is more appropriate as an average. As efficient showerheads and efficient clothes washers have proliferated over the last several years, this number was bound to decline. In spite of that, we still find the economics of the most advanced water heating technologies to be very attractive. **So we suggest that the Department use a better researched number. A much better method of analysis was that used by the Lawrence Berkeley Laboratory staff for the water heater rulemaking analyses. In fact, much of that excellent analysis is relevant to the discussion, and should probably be reviewed in more detail.**

8) Oil-fired technologies seem to deliver a narrower band of performance at this point, and so the place for such equipment in an Energy Star water heater program component is limited. Only if the program focuses on the most modest of efficiency improvements across all fuel types will an Energy Star specification for oil-fired equipment make sense.

Conclusion

While there is a substantial energy savings potential in the residential water heating end use, we are not convinced that the Energy Star program is an appropriate vehicle for capturing some of it. As the report points out, the simple payback period for the proposed electric resistance efficiency level is less than three years. Clearly the 2004 standards should have been set higher. But we repeat ourselves.

The greatest savings potential, and the biggest opportunities for market improvement are to be found with the most advanced natural gas (instantaneous and condensing) and electric (heat pump) technologies. Given the market barriers and the site-specific installation considerations, these technologies need the most help and the longest period for transition. If they were the focus of the program, water heaters could become one of the more stable elements in the Energy Star portfolio. The alternative, focusing on the smallest incremental step, would be relatively short-lived, and would accomplish little beyond what utility and other programs are accomplishing today without the Energy Star presence. Add to this the fact that many water heaters are delivered through a contractor channel that has had little or no connection to such program concepts thus far, and we tend to doubt the appropriateness of the concept.

In spite of our misgivings, we remain committed to assisting the Department in concluding this assessment, and to considering the ultimate program specifications should they be developed. Let us know how we can be of further assistance.

Charlie Stephens
Policy Analyst
Oregon Office of Energy
Conservation Division
Technology Development Section

Ph: 503 378-4298
Fax: 503 373-7806
e-mail: charles.m.stephens@state.or.us